BBC RD 1979/18

Engineering Research Report

The work covered by this report was undertaken by the BBC Research Department for the BBC and the IBA

SATELLITE BROADCASTING: results of a preliminary coverage survey in the U.K.

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September 1979

BBC RD 1979/18
UDC 621.396.946

SATELLITE BROADCASTING: RESULTS OF A PRELIMINARY COVERAGE SURVEY IN THE UK

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Summary

In order to discover the types and extent of local obstructions to domestic reception of future satellite broadcast transmissions to the UK, a questionnaire was distributed to a limited number of the staff of organisations concerned with broadcasting. The report describes the basis for the survey, and gives an analysis of the results; it is estimated that the loss of possible coverage by individual reception, through shadowing of all parts of the premises occupied, would be less than 0.5% of the population.

Issued under the authority of

Head of Research Department

Research Department, Engineering Division
BRITISH BROADCASTING CORPORATION
September 1979
(RA-181)

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SATELLITE BROADCASTING: RESULTS OF A PRELIMINARY COVERAGE SURVEY IN THE UK

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1. Introduction

As a result of the successful planning which was completed at the World Administrative Radio Conference in Geneva in 1977,[1] each country of the world, except the Americas, knows the position assigned to its broadcasting satellite, the modulation system, the frequencies assigned to its channels and the power flux density assigned to its beams. Domestic receiving terminals may therefore be designed, built, installed, aligned and tuned to give good reception of the country's satellite-borne programmes, when the plan is fully implemented.

However, although the planning took account of possible interference from other transmissions[2] and made allowances for probable signal attenuation by cloud and rain,[3,4] it was unable to forecast the attenuation caused by local obstructions to reception like hills, buildings and trees. As the frequency of satellite transmission is near to 12 GHz (the wavelength being of the order of 2.5 cm) the shadows cast by such obstructions will be relatively 'hard' and a change of a few feet in the position of the receiving aerial may make all the difference between good reception and none at all.

To assess the extent of these obstructions on coverage by a UK broadcast satellite is clearly a matter of assessing individual receiving sites and finding whether the best choice of aerial position has a clear line of sight to the satellite. This may be accomplished, before the satellite is launched, by examining the shadows caused by the sun when it passes behind the assigned satellite position.

2. Use of the sun as a site test transmitter

Over a year the sun's path across the sky appears to oscillate ±23.5° about the celestial equator. To a particular observer, the sun's position and a geostationary satellite's position will be nearly the same at some time on two days in the year, each not far from one of the equinoxes, depending on the observer's latitude. An appendix, Section 11.1, shows how to calculate days and the time of day of this conjunction. Because of parallax between the distant sun and the nearer satellite, the precise conjunction will occur at different times on different days at different points on the Earth's surface. However, within the UK, with its satellite at longitude 31° West, the conjunction will be sufficiently close at all points at 2 hrs. 52 mins. p.m. on October 13th to allow useful shadow observations to be made, provided that the sky is clear. Similar observations may be made on March 2nd, except that allowance must be made for the absence of leaves on deciduous trees. In practice, a tolerance of ±4 days and ±15 minutes, which amounts to an angular tolerance of about ±2 degrees, is not likely to have a great effect on the results of the observations.

3. Method of assessing coverage

Coverage of the satellite transmitter will be limited by shadowing in several ways – from hills, buildings and trees. Shadowing from hills and large buildings – tall blocks in towns for example – may be assessed by aerial photographs of the sun's shadow on the appropriate date; this has been done for the town of Frankfurt,[5] for example, where the shadows of tall buildings were measured and estimated to reduce the satellite's coverage by about 1% of the total population of the town. It is assumed that in these cases, the shadowed population would receive a service by means of a local wired distribution network instead of by direct reception – possibly one network for the shadow of each large building. Such a distribution network would undoubtedly be required in any case to provide a service to those living inside the same tall buildings, but facing away from the satellite, so that all those in the one shadow could be fed from a single receiving terminal on the top of the building. Less amenable to aerial photography of shadows will be the problem of residents in suburban and rural areas, where the shadows are caused by smaller buildings, or within the building (for example, a north-facing flat) and by trees. These are better assessed by individual inspection and by the dwellers themselves. The question arises of how to approach them, and what to ask them.

It would be possible for the BBC to publicize a nationwide survey and to distribute copies of a questionnaire in the form of a pre-paid reply form in the Radio Times. Similarly, the BBC Audience Research Department would be able to conduct a personal, doorstep survey of a significant sample, say 20,000, in the requisite short time around October 13th. But both these operations were estimated to be quite costly. It was, therefore, decided to make a preliminary survey using mainly the engineering staff of the BBC, but with some assistance from other interested organizations. The result of such a survey would not represent a statistically-significant random sample but would give a useful guide to the size of the problem at a minimal cost.

4. Design of questionnaire

A copy of the questionnaire is shown in appendix Section 11.2. The first half was designed to be informative but informal and to indicate the problem requiring solution and some possible ways of solving it. The second half was designed to extract, by only a few questions, as much information as possible from the recipient about obstructions to reception and how these are related to where they live and the type of residence. Comments were encouraged and being, as it were, 'in house', there was hopefully a fairly uninhibited atmosphere in which pertinent views could be expressed. The design of the questions had its shortcomings, as will emerge from the discussion, but the number of replies was small enough for individual inspection. Doubtful interpretations were clarified by a telephone call or a letter in several cases.

5. Distribution and returns

1500 questionnaires were issued to engineers of BBC, IBA and BREMA. Initially, sufficient copies were sent to each department to cover about 80% of the middle and senior engineering staff, including both transmitter engineers and structural engineers. The actual distribution was left entirely to heads of department. There were many requests for extra copies. Luckily, in contrast with 1977, the period October 8–16 1978 was generally sunny and calm and most leaves had stayed on the trees, so that a high proportion of completed questionnaires was expected.

440 questionnaires were returned, complete in all essential details. One enthusiast very kindly sent sketches of the shadows on all the houses in his road. Another, travelling on BBC business that week, sent in returns for each port of call, one of them (the only one) from a castle.

Of the 1060 forms which were not returned, it is likely that many were not received in time for a useful observation; there were some complaints that the distribution was a little late. No doubt there were many other recipients for whom the possible observation times were inconvenient. But it is also likely, from hearsay, that many recipients would have replied if there had been any interesting obstructions, but underestimated the importance of returning reports indicating that there were no shadowing problems in their case. We may therefore suggest that the analysis, based on the 440 replies, will tend to overestimate the proportion of people affected, a factor which is borne in mind in the final conclusions.

6. Analysis of replies

6.1. Shadows from hills, buildings and trees

Of the 440 replies, 170 said that there were no obstructions at all (within the intention of the questions). The remaining 270 observed either partial or complete shadows on part of their house or garden. The numbers of cases of things shadowing and shadowed are given in Table 1.

It would appear from Table 1 that, where difficulties arise, the use of a site near the chimney or on the roof-top is very likely to provide a solution to the shadowing problem. We shall pick out the results for the chimney as representing the most likely part of the house to be free from shadowing.

Buildings appear to produce a relatively large number of *partial* shadows; many reports of these are believed to include the dark (north) side of the building itself, its chimney and their shadows on the garden. A slight change in the wording of question number 10 would have avoided this doubt in interpretation (which was pointed out too late for revision by the author).

This shortcoming of the question cannot, however, affect the reported extent of *complete* shadows. There was only one report of complete obstruction by a building; this is retained in the analysis but, since the report was unqualified, it might be reasonable to add it to those which, though facing north, had access to a shared roof or chimney, and said so. These cases will be discussed in Section 6.2.

Trees caused a greater number of complete shadows than buildings. The only two cases of complete shadowing by trees were in High Wycombe, screened from the SSW by a belt of tall trees owned by the National Trust. There

TABLE 1

Shadows on 270 dwellings

	Number of shadows, complete/partial			
	on the garden	on the house	on the chimney	TOTAL
by hills	0/7	0/1	0/0	0/8
by buildings	6/123	1/127	1/14	8/264
by trees	7/80	6/63	2/4	15/147
TOTAL	13/210	7/191	3/18	–

were about 20 homes similarly shadowed in the same estate. The remaining four of the six reports of completely shadowed houses had clear or partially-clear chimneys. Hills produced no reports of complete shadows though many thoughtful respondents, living near Dartmoor and the Pennines, said that, while *they* were in the clear, many of their neighbours would be 'under the hill'. Further enquiries of these respondents, however, revealed no such cases.

A summary of the results for the 440 replies concerning complete shadowing is given in Table 2.

The probable error is obscured by the use of such a small and specialised sample of the population. But for the reasons given in the discussion above, the figure for buildings is probably excessive and we could probably neglect this item if we assume access to an aerial within the same building. The figure for trees may need the same qualification and this point will be raised again in discussing remedies in Section 7.2.

A different sort of shadow, that caused by moving aircraft, was not directly assessed by this survey. Nevertheless, based on one report,

TABLE 2

Complete shadows of house and chimney

	Number in sample of 440	Percentage in sample	Percentage refined estimate	Order of number forecast in 20M households
(1) By hills	0	0	0.1	20,000
(2) By buildings	1	0.22	0.2	40,000
(3) By trees	2	0.45	0.4	80,000
Total	3	0.67	0.7	140,000
Total less (2)	2	0.45	0.5	100,000

TABLE 3

Preferred aerial positions

Chimney	Roof	Gable	Wall	Garage	Front Garden	Back Garden	Other
75	75	55	64	56	8	22	70

the possible impact of aircraft shadow is described in Section 6.3.

6.2. Preferences, difficulties and objections

Participants were asked, in question No. 7, which of the possible positions for the aerial they would prefer. In the great majority of cases their preference was clear, or sufficiently clear, of shadow to be satisfactory for reception. The question offered only a '3 ft dish weighing 10 lb'; no other design was offered. Table 3 gives the preferences.

The results showed a general preference for keeping the aerial off the ground, even if not forced to do so. Those who preferred a garden aerial did so mainly for reasons of appearance, local restrictions or windage. The prospect of a rash of suburban 3 ft dishes clearly disturbed 30 participants and some took trouble to find out, discreetly, the possible reaction of the local authority; this was, in 12 cases, reported as unfavourable even where u.h.f. aerials were permitted.

Windage was seen as a primary consideration in 11 cases. A reply from Shetland preferred a back-garden dish, mentioning that the wind velocity in the previous September had reached 158 m.p.h. But several others noticed that the orientation of their houses demanded a large, offset bracket to enable the dish to face the satellite. This bracket, they argued, would be heavy, ugly and might damage the structure of the house. Possibly for the same reasons, many preferred to mount the dish on the garage, an extension roof, an out-building or the garden.

'Other' sites were preferred by 70; of these, only 12 specified a distinct choice. Four of them were optimists, one preferring the dish in the attic and three radio-amateurs each selecting a 30 ft mast or tower, though there were clear sites on the house in each case. (But see Section 7.4.)

Dish-sharing was mentioned in seven replies as the only solution to their problem, partly on mechanical grounds and partly appearance. These suggestions came from those in the north-facing flats, maisonnettes or terrace-houses where one chimney-stack would have to be shared by, say, four households. This point is discussed in Section 7.1.

6.3. Aircraft shadows

Aircraft interference was forecast by one respondent living near to Heathrow airport. His description is so interesting and clearly stated that it is given here verbatim.

'Aircraft approaching London Heathrow do so at a shallow angle over a distance of at least 10 miles on either of two parallel tracks approximately ¾ mile apart, changing over each day at 1500 hours. At this site (Kew) the aircraft are either directly overhead at 1900 feet or ¾ mile to the South on a heading towards runway '28 left'. Aircraft on the latter route seen from here have an elevation very nearly equal to 'E' on your sketch (in the questionnaire) or would have exactly so at a nearby location.

Aircraft descend on their approach at approximately 315 feet per mile maintaining an accurate line; one such case operating at present is the Boeing 727 with a total length of close on 50 yards and an approach speed of say 180 m.p.h. (landing speed is 155 m.p.h.). Although in this case the duration of obstruction may be no more than 0.5 seconds the resultant signal failure could be repeated many times – at present up to 40 times an hour for several hours at a time. I imagine, therefore, that this type of interference could be experienced along two narrow parallel lines over a distance of some ten miles'.

It is believed that the descent 'corridor' is only 20 yards wide so that an unfortunately-situated dwelling may expect, say, twenty half-second drop-outs or noise bursts in reception every hour. The two 'shadow-lanes' would fall on approximately 1000 houses between Fulham and Hounslow with a fair degree of regularity and precision. The possible subjective impairment of satellite broadcast reception in these lanes is discussed in Section 7.3.

7. Main technical problems indicated by the survey

7.1. Building shadows: sharing of aerials

The survey revealed little complete shadowing by other, large buildings of the type found photographically in the town of Frankfurt.[5] But, on a smaller scale, it indicated many urban and suburban situations (for example, flats, maisonnettes and terraces) in which one aerial might have to be shared between several households. The solution to the latter problem is not difficult nor costly, for the following reason.

It is likely that the 'standard' domestic receiving installation[6,7] will be a double-superheterodyne system with an untuned frequency-converter mounted close to the aerial, giving an amplified intermediate-frequency output at about 1 GHz for cable-connection to the second, tuned, converter close to the television set. It would be a relatively simple matter to instal a distribution amplifier to share this first i.f. signal, provided that the size of the building did not necessitate very long cable runs. Each sharing user would have the same tuning options as if the installations were separate.

Larger buildings (for example, high-rise flats) would require longer cable-runs in their distribution systems to feed those on their ground floors. A single distribution system may be extended to feed those living in separate dwellings at the far end of the building's shadow. Such a system would probably supply up to a hundred receivers, with a separate feed for each programme, either by v.h.f. cable or by optical fibres.[8]

It is impossible to derive from this survey an accurate national figure for households shadowed by buildings in the UK but it is of interest to make an extrapolation from the estimated shadows in the town of Frankfurt.[5] The urban population of Frankfurt is about 0.2M households; that of the UK is about 4M households, including London Boroughs (2.3M) and provincial cities (1.7M). If we assume the same proportion (1%) for urban shadowing in the UK and Germany, then we may expect buildings in the UK to shadow 40,000 households or 0.2% of the total 20M households in the UK as a whole.

7.2. Tree shadows

The survey discovered two cases of total shadow from trees. These two cases occurred in a single area in which there were subsequently found to be approximately 20 other similar cases. There may be many such areas in the UK and if the numbers of dwellings affected in the same area is sufficiently high, the most satisfactory solution may be similar to that given in Section 7.1 for the high-rise building, involving sharing a receiving and distribution system.

Though the survey did not find any *isolated* cases of complete obstruction by trees, these will occur. The solution in these cases may be difficult or costly. The national figure for households requiring a distribution system because of obstruction of the aerial signals by trees cannot be estimated by extrapolation from the survey. At an upper limit, we can round the figure to about 0.4% or 80,000 households; trees are thus potentially the most important cause of shadowing but it is very likely that the figure from a more representative sample of the whole of the UK would be considerably less than 0.4%.

7.3. Aircraft shadows

The possible interference-like effect of aircraft shadows was reported by one observer, and his description is given in Section 6.3. The effect of this interference on reception will be primarily a half-second reduction of the carrier level below the threshold level, resulting in a burst of noise, recurring at the rate of one every three minutes or so, as incoming aircraft descend towards Heathrow. Similar effects will no doubt occur in the shadows of the approach lanes at other airports in the UK, many of which will affect a large number of dwellings. The effect on the received picture may last for a longer period, say one second because of a loss of synchronisation during the loss of signal.

How to assess the importance of aircraft shadows, and the numbers of viewers affected, will need a separate study. The effect is clearly an interference rather than a loss of coverage and the number of households affected in the UK may be less than 10,000. Short of a costly system of diversity reception, it is hard to envisage a complete solution to this form of interference, especially as the affected area is so great in length. Much may depend on the design of the receiver: it is possible that a modified receiver with some form of noise-operated muting circuit may give acceptable reception in these areas.

7.4. Windage and obtrusiveness of dish aerials

The simplest form of domestic aerial having the required aperture and directivity for direct satellite broadcast reception is probably a paraboloid or dish 0.9 m diameter (3 ft) with its axis pointing to within 0.5 degrees of the satellite. Such a structure, however, though simple to make and fit with a feed system, will be prone, in almost all cases, to catch the wind and catch the eye. Many of the participants in this survey regarded these features as undesirable and even dangerous, and suggested that the local authorities either should or would impose restrictions on their use in many built-up areas.

The questionnaire deliberately mentioned only the simple, 3 ft dish aerial so as to draw out these opinions. The replies clearly indicate the need for a compromise design of aerial to satisfy certain viewers, architects and environmentalists. Several other designs[9,10,11] are possible which may be more acceptable, but since the size of the aerial for a given performance cannot be significantly changed, the problem is more one of trying to incorporate it or blend it with existing structures. Further study is also needed to find cheap methods of fabrication. An ideal design would probably be flat, so that it could be disguised as part of a wall or a tiled roof, and electrically-slewable in its direction of reception, so that it could be mounted on surfaces having a wide range of inclinations. For example, one German design is said to resemble a window-box.[12] A choice of designs, each resembling a different part of a house, would be more suitable from the environmental point of view and may reduce the necessary range of slewability in each design.

An attic-mounted aerial (dismissed as optimistic in Section 6.2) may be not only environmentally attractive but also, in certain circumstances, adequate for reception. Provided that the orientation of the roof is suitable and that the aerial can 'see' the satellite through a 3 foot diameter panel of roofing material that is transparent at 12 GHz (a large, single-panel thin glass or plastic skylight for example) the resulting attenuation may be acceptable. However, if the roof is not already endowed with the required properties, it may be a costly operation to make it so, but the concept is certainly worth considering in the design of future houses.

At the other extreme, where there may be an isolated case of complete shadow and where environmental considerations may be abandoned, it would seem natural (as it does for u.h.f. reception) to mount the aerial on a tall mast so that it may emerge from the shadow. Such a mounting has been suggested in the replies to this survey (Section 6.2) not for shadow-avoidance but simply because the masts already exist. However, it is unlikely that a 30 ft mast designed for h.f., v.h.f. or u.h.f. reception would be sufficiently rigid for reception at 12 GHz with a 3 ft diameter dish, in even a moderate wind. For example, if the mast should sway enough to deflect the axis of the dish by 1.5 degrees, the resulting 7 dB attenuation would reduce the signal level to below the noise threshold in nearly all cases. Similar considerations apply to other popular misconceptions of satellite-receiving aerial mountings even though they may be adequate for a small u.h.f.-receiving aerial.

8. Conclusions

A preliminary survey has been carried out in order to discover the extent of local obstructions to possible future satellite broadcast reception. The survey was limited to a relatively small number of participants who specialised in broadcasting so that no firm national coverage figures can be derived directly from the results. On the basis that viewers would be prepared to site the aerial where necessary on their house or premises, the results suggest that less than 0.5% would be deprived of the possibility of direct reception. The survey was perhaps more useful in giving an indication of the difficulties that may arise and of the possible and preferred locations for the aerial (Tables 1 & 3).

While trees and buildings present local problems which will require local solutions in the form of small distribution systems, each run on a communal basis, there is a need to develop an efficient, individual domestic aerial design which is less obtrusive than a 3 ft dish so that it may be a more acceptable addition to the environment and less of a potential hazard in a high wind. There will be scope for distribution systems in many areas, even where shadows are no problem.

Interference caused by aircraft shadows may affect a significant number of viewers living below the approach lanes near large urban airports, but this is not so much a loss of coverage but rather a problem affecting the quality of direct reception in certain limited and well-defined areas.

9. Acknowledgement

The author is indebited to those within BBC or contacted through IBA and BREMA who willingly co-operated by responding to the questionnaire and, in particular, to those who provided additional helpful information and opinions which have been reflected in the body of the report.

10. References

1. I.T.U. 1977. The Final Acts of the World Administrative Radio Conference on Satellite Broadcasting. International Telecommunications Union, Geneva, 1977.

2. HARVEY, R.V. 1976. Simplifying the planning of frequency assignments for satel-

lite broadcasting. *EBU Review*, Technical No. 159, October 1976.

3. EATON, J.L. 1977. Satellite broadcasting: slant-path attenuation through rainstorms. BBC Research Department Report No. 1977/7.

4. MILLINGTON, G. 1975. Geostationary-satellite earth coverage. *Proc. I.E.E.*, **Vol. 122**, No. 2, February, 1975.

5. THEILE, von R. *and* SCHULTHEIS, H.-P. 1978. Limits of satellite-broadcasting coverage due to shadowing. *Rundfunktechnische Mitteilungen*, **Vol. 22**, No. 5, October 1978.

6. PHILLIPS, G.J. 1977. Domestic installations for direct broadcasting from a satellite. BBC Research Department Report No. 1977/24.

7. HAWKER, Pat. 1979. Low-cost satellite-receiving techniques. *Wireless World*, January 1979.

8. FELL, P.H. *and* KENT, A.H. 1975. Television transmission equipment and systems. European Conference on Optical Fibre Communications, First, London, 16 – 18 September 1975. (IEE Conference Publication No. 132, p. 185.)

9. PHILLIPS, G.J. 1972. Direct broadcasting from a satellite. *Journal IEE, Electronics and Power*, p.349, October 1972.

10. BRADLEY, L.K. *and* KING, R.W. 1972. Satellite broadcasting: a zoned reflector aerial for the domestic reception of Band VI. BBC Research Department Report No. 1972/10.

11. MILLARD, G.H. 1972. A 12 GHz domestic receiving aerial for satellite broadcasting. *EBU Review*, Technical No. 135. October 1972.

12. CUCCIA, L., QUAN, W., HELLMAN, C. 1977. Above 10 GHz Satcom bands spur new Earth Terminal development. *Microwave Systems News*, March 1977, p.39.

11.1. Appendix 1: Calculation of Sun/Satellite Conjunction

1. Write $r = 6.4$ (Earth radius, 10^6 km)
$R = 42$ (Orbit radius, 10^6 km)
A = latitude of observer, degrees
B = longitude of *observer*, relative to *satellite* (East positive)
$C = \sin A$
$D = \cos A \cos B$
$E = \cos A \sin B$

2. Find the celestial declination of the satellite

$$dec = \arctan\left(\frac{-rC}{\sqrt{(R-rD)^2 + (rE)^2}}\right)$$

3. Find (from an ephemeris) the DATE on which Sun has the same declination. Note that in the Northern Hemisphere, A is positive but the declination is negative.

4. Note (from ephemeris) the Equation of Time for that day, Te. This is sundial time minus G.M.T.

5. Find the mean time of the conjunction relative to mean noon.

$$Tm = \frac{1}{15}\left[B + \arctan\left(\frac{rE}{R-rD}\right)\right] \quad \text{hours}$$

6. The required apparent time of the conjunction is

$$Tap = Tm - Te \text{ (+ 1 if B.S.T. operating) hours p.m.}$$

7. Take Manchester, for example, and the UK broadcast satellite.

$A = +53.5$
$B = -2.2 - (-31)$
$= +28.8$

$C = 0.80$
$D = 0.52$
$E = 0.29$

$dec = -7.6$ or $-7°\ 36'$

The ephemeris gives $-7°\ 33'$ on 13th October 1978 and an equation of time of +13m 32s. (Te = +13.5m).

Tm = 2.1 hours or 2 hrs 6 minutes, whence

Tap = 2 hrs 52½ min p.m. B.S.T.

SMW

11.2. Appendix 2: The Questionnaire

SATELLITE BROADCAST COVERAGE SURVEY

I ask for your co-operation in helping me to assess the extent of a problem concerning the reception of future television broadcasts from a UK broadcasting satellite. But, before asking you to read the instructions and find the answers to the questions overleaf, it may help you if I briefly describe what we already know about the subject.

Satellite broadcasting has not yet arrived but most of its problems have been solved - at least in theory. Although experimental broadcasts are in progress in some countries, the first countries to make general use of satellites for broadcasting national television programmes will be those with the greatest need for 'instant' coverage. The UK may not be one of the first to launch such a service, even though we have been one of the major contributors to the technical solutions. In finding a long-term solution, a great deal of international agreement has been reached on how best to serve most people for most of the time. Some of the more important decisions are these:-

1. Frequency. The 12GHz frequency band will be used: this is wide enough to have enabled the Broadcasting Satellite Conference in Geneva, 1977, to plan for 5 TV channels (or 4 TV plus up to 8 stereo sound) for each country in Europe, Africa and Russia. The wavelength is only about one inch. The waves can fairly easily penetrate clouds and rain but cannot penetrate buildings, hills or trees without considerable loss of power. A microwave dish aerial, and a new receiver or adaptor, will be required.

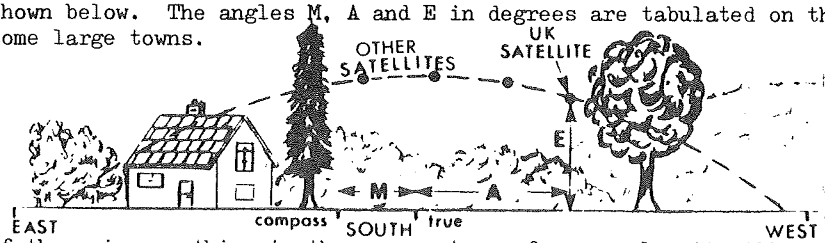
2. Power. This is to be the lowest power sufficient to serve the area of the country. For the UK, the power for each television channel works out at a mere 150 watts. Though spread thinly over the UK from Folkestone to Fermanagh and from Scilly to Shetland, there will be enough for a good TV picture if each household collects the power falling on an aerial dish 0.9 metres (3 feet) diameter, the size of a large dustbin lid. An aerial of this diameter at this wavelength will act like a radio-telescope with a field of view of only 2 degrees across, so that it must be pointed fairly accurately at the satellite. The advantage of this narrow beam is that it reduces the possibility of interference from adjacent satellites and allows the same frequency channels to be used for other countries.

3. Satellite Position. To make the satellite transmitters appear stationary they must move in a circular orbit around the Earth's axis at the same rate and direction as the Earth. They will then appear to stay 36,000 km above fixed points on the equator. Each satellite will have a specific longitude; so many are needed in the plan that they have been assigned positions only 6 degrees apart. Each position will generally be chosen well west of the longitude of the area served so that the Earth's shadow can never shut off the satellite's solar power supply before say 1 a.m. local time. The longitude assigned to the UK satellite is 31° West. If we know our exact latitude and longitude we can calculate exactly how to point our dustbin-lid aerial at the satellite before either is there. So, if you tell me where you live, I could ask you to go home with a compass and sextant and tell you where to look for the UK satellite! You could then tell me whether there would be anything in the way of the signal, such as a hill, building or a tree, and where you would have to be to get a clear view.

That is what I want to know. But there is a less energetic way of finding out; this is by looking at the shadows on the house and garden when the Sun can represent the satellite, that is, at 3 p.m. on the 12th October, or at a similar time on adjacent days when - hopefully - the Sun is not obscured by cloud.

P.T.O.

The position of the UK satellite in your local sky will be something like that shown below. The angles M, A and E in degrees are tabulated on the right for some large towns.



	M	A	E
London	6.5	37	25
Birmingham	8	35	24
Bristol	8	35	25
Manchester	8.5	34	24
Belfast	10.5	30	24
Edinburgh	9.5	33	21

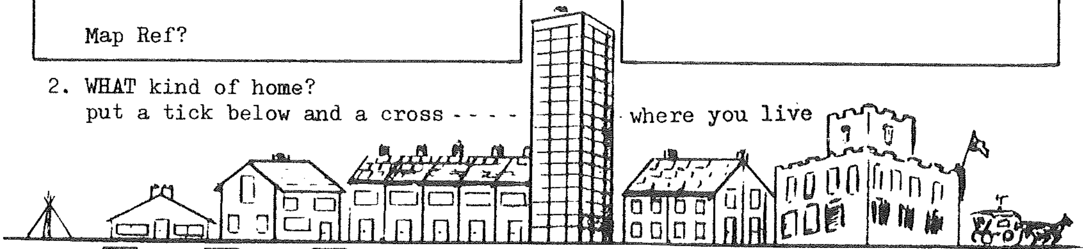
If there is something in the way, a tree, for example, it will also obstruct the Sun (weather permitting) at about 3pm on the 12th October. The shadow on your home at that time will tell me what I want to know. Please help by answering as many as possible of the following questions.

1. WHERE do you live?
Home address:

Map Ref?

Name:
Office address:

2. WHAT kind of home?
put a tick below and a cross - - - - where you live



Tent ☐ Bung ☐ Semi ☐ Det ☐ Terrace ☐ Flat ☐ Maist. ☐ Castle ☐ Caravan ☐ .... ☐

3. HAVE YOU A TV receiver at home now? Tick YES ☐ or NO ☐

4. HOW does it get its signal? Tick

Room aerial	☐	Individual	☐	Wired distribution system:	
Loft aerial	☐	Shared	☐	Feeding whole building	☐
Outside aerial	☐			Feeding several houses	☐

5. ARE THERE any local restrictions on outside aerials? Tick YES ☐ or NO ☐

Now suppose that you have a satellite broadcast receiver and you wish to put up a 3ft. dish aerial weighing 10lb. on a rigid mount outside the house facing SSW.

6. WHERE could you put the dish?
Put ticks where a suitable position might be found

7. WHICH one would *you* prefer?

8. WHICH would be allowed under Q.5?

ACTION: If it is sunny and convenient on any afternoons from 8th-16th October between 2.45 and 3.15pm BST please look for shadows at all the places in the table.

9. HOW much shadow?
If hardly any - leave blank
about half shadow - put - - - - - /
completely shadowed - put - - - - - - X
and note the DATE and TIME

10. WHAT caused the shadow?
If a tree put - - - - - - T
a building - - - - - - - B
a hill - - - - - - - - - H
e.g. /T

Chimney	Roof	Gable	Wall	Garage	F.Garden	B.Garden	Date	Time

If you cannot answer these questions from your own or a delegate's observation, please make a rough guess from your knowledge of the surroundings, and the details given at the top of this page. The answers may be obvious to you without looking!

Any comments?

Please return the completed form to me. Thank you for your interest, time and help.

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